

Statement of

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before the

**Subcommittee on Space and Aeronautics
House Committee on Science
U.S. House of Representatives**

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Chairman Udall and Members of the Subcommittee:

Thank you for the opportunity to comment on the Federal Aviation Administration's research and development capability. I am a Professor of Aeronautics and Astronautics at the Massachusetts Institute of Technology and the Co-Chair of the FAA Research and Development Advisory Committee (REDAC). The REDAC is a Congressionally mandated committee which advises the FAA Administrator on research and development.

The roll of research and development in the FAA is to support current and future operational requirements as well as the agency's mission of providing a safe, secure, and efficient global aerospace system. The US has the best and highest performance Air Transportation System in the world. There are, however, increasing signs that the system is under stress. Let me highlight a few examples.

The system is approaching its capacity limits at key points. As a result, due to increasing demand (Figure 1) and the highly integrated nature of the network (Figure 2), nominal interruptions, such as weather problems, result in a nonlinear increase in system delay. This can be seen in the national data shown in Figure 3 where summer delays began to amplify in 1998. Delays were subsequently moderated due to traffic reduction following the attacks of September 11, 2001. As traffic levels have returned, the overall delays have grown to record levels and expected to grow in the future. The FAA and airlines have actually done a remarkable job of minimizing delays given the limited airport and system capacity, but major weather related delay events, such as those at Denver, New York, and the problems last weekend on the east coast are further indications of system vulnerability.

Other factors stressing the system are emerging requirements for increased fuel and environmental efficiency. Aviation fuel prices (Figure 4) have, like other fuel sources, increased markedly in recent years and are likely to remain high. Environmental issues are becoming increasingly prominent internationally and at home. Concern over aviation noise continues to limit our ability to expand operations at key airports and the increased attention on global warming is driving requirements on aircraft emissions.

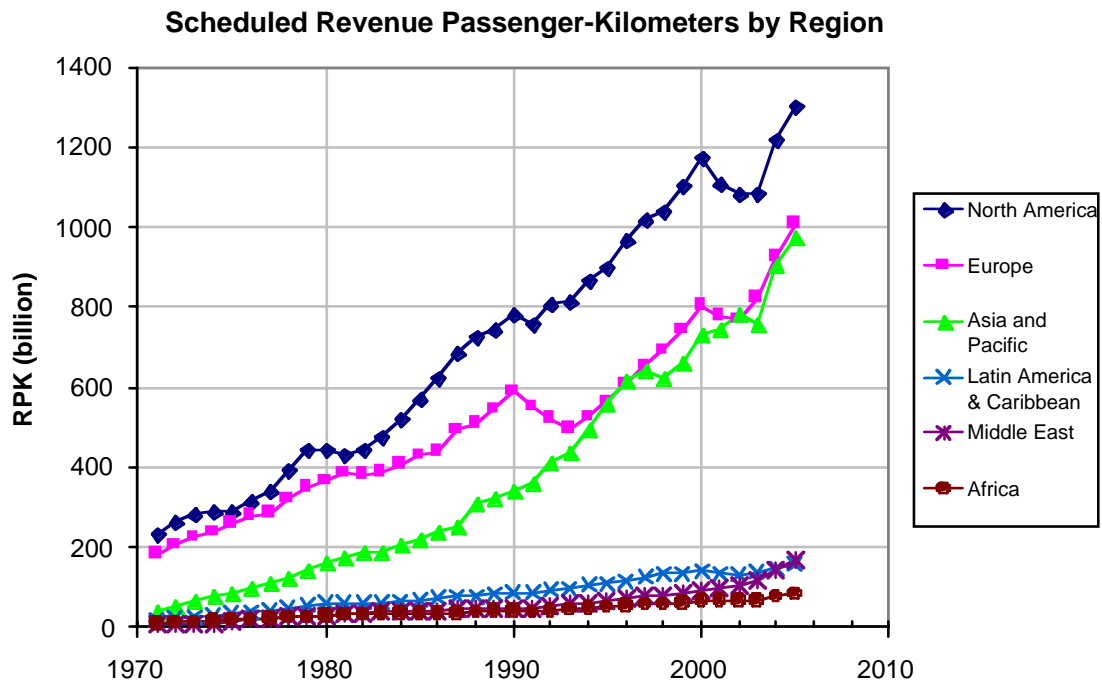


Figure 1. Passenger Demand Trends (Data Source: ICAO)

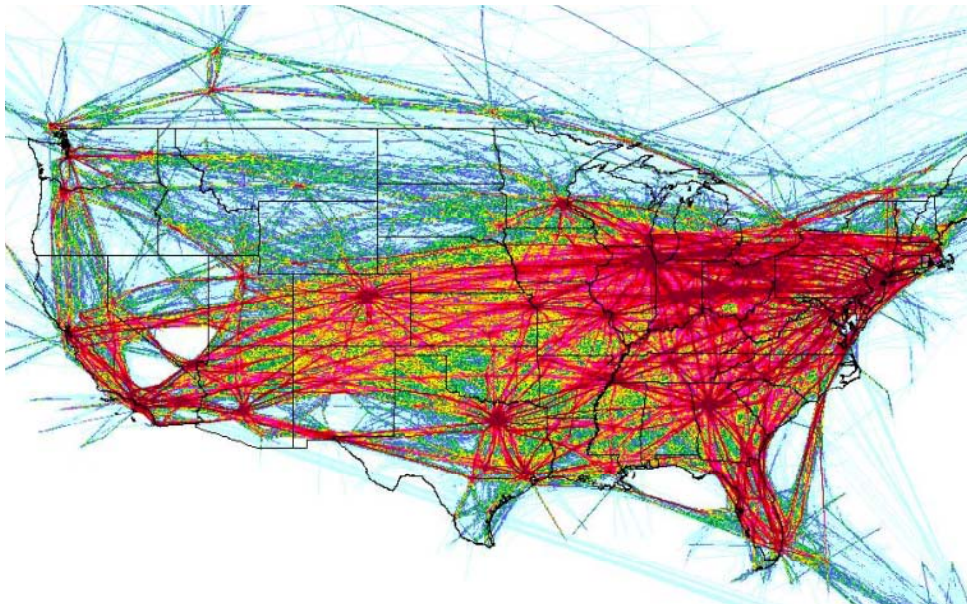


Figure 2. U.S. Air Traffic Density (Source: FAA ETMS Data)

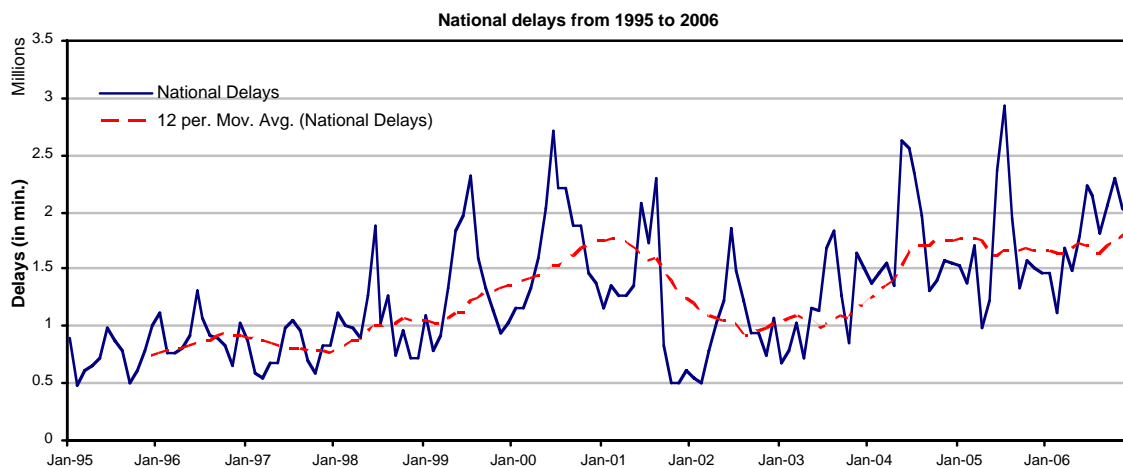


Figure 3. U.S. Delay Data (Source: P. Bonnefoy analysis FAA OPSNET)

Average Crude Oil and Jet Fuel Prices

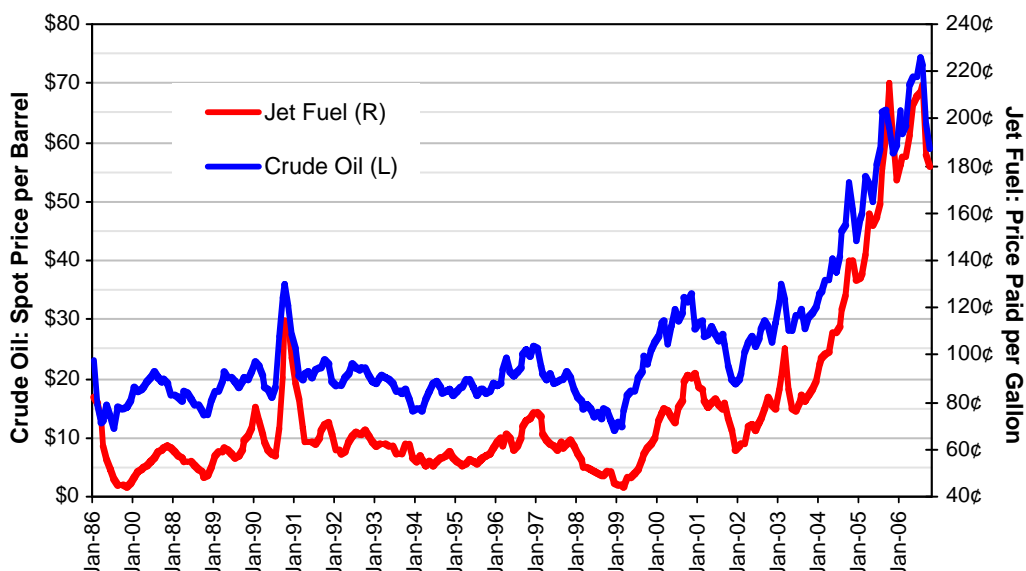


Figure 4. Fuel Price Trends (Source: ATA)

I will comment briefly on the specific questions which you have asked me to address.

What concerns, if any, does the REDAC have about the content and priorities of the FAA's R&D program, and what would the REDAC recommend be done?

The REDAC has been generally supportive of the specific content of the FAA's R&D programs given the limited resources allocated to R&D and system development. The REDAC subcommittees review the R&D programs in the areas of Airports, National Airspace System Operations, Human Factors, Environment & Energy, and Safety and generally have concurred with the FAA's R&D plans.

The REDAC has been concerned for a number of years that the declining support for aeronautics R&D both at the FAA and NASA have resulted in the decline of national aeronautics capability. In some important areas research efforts are below critical mass and others are not supported at all.

The REDAC is also concerned about the ability of the FAA to attract and retain highly skilled personnel in emerging technology areas which are important to the FAA R&D mission. Important efforts such as the Safety Management System are not as effective as they should be due to lack of intellectual capital. The REDAC has recommended the FAA increase its capability in key emerging areas such as; complex safety critical software, system engineering, and safety data mining.

What impact is NASA's restructuring of its aeronautics program having on FAA's R&D program?

The restructuring of the NASA aeronautics program has significant implications on the FAA R&D program. Over the past decade, as aeronautics research support in the U.S. has declined, the FAA and NASA have worked to integrated their research programs to avoid duplication and to cover key topics in the areas of aviation safety, aircraft technology, and air traffic control. NASA has shifted its focus to longer term and more fundamental aeronautics research and developing a core knowledge base. While this is a reasonable strategy given their limited resources it will be incumbent for the FAA or some other agency to cover shorter term and applied civil aeronautics issues which NASA had previously addressed. It should be noted that this has been a difficult area to assess as the NASA program has been in transition and it is still not fully clear what the full content of the NASA's program will be and it's consequent impact on the FAA.

There are, however, several areas of concern. One is the technology maturity gap problem. As NASA has limited its focus on lower Technology Readiness Levels (basic research and technology feasibility) the FAA will have to pick up more responsibility for moving key technologies for the NAS through the mid TRL levels (development and demonstration). This will be in addition to the FAA's normal efforts at high TRL level system integration. The REDAC, among others, have highlighted this issue and the FAA has proposed several efforts to address the TRL gap. In some areas (e.g. Environmental) the technologies will

benefit both industry and government so the FAA has been able to propose cooperative agreements with industry such as the Research Consortium for Lower Energy, Emission, and Noise Technology Partnership. In other areas (e.g. Air Traffic Management and Safety Analysis) the FAA will be the primary technology user and will have to manage the higher TRL level efforts. This will require resources and will likely be a significant challenge for the FAA.

Another area of concern is the maintenance of aviation safety and human factors databases developed through long term NASA efforts. Through the Aviation Safety and Reporting System (ASRS) and several human factors field studies, NASA has developed several databases which are national assets and relied on by the FAA and other aviation safety researchers. If NASA does not continue to support these databases it will be necessary to protect these resources.

Finally there is the issue of nurturing and maintaining the national capability in applied aeronautics. It is important for the FAA and NASA to work together to encourage and enable the next generation who will move the system forward. There are some notable successes such as the FAA Centers of Excellence and the recent NASA NRA program. However, the general decay in aeronautics research coupled with re-structuring uncertainty has had an adverse impact on university programs and the pipeline of young talent attracted to solving the challenges which the FAA will face.

To what extent has FAA's R&D program been integrated with the needs of the JPDO, and is that an appropriate level of integration?

To the extent that the JPDO has been able to define near term operational and R&D requirements the FAA has begun to integrate them into its plans. Examples include the initial implementation of ADS-B and System Wide Information Management (SWIM) as well as increased FAA support for environmental programs. However, the NextGen system is still a work in progress and is not sufficiently defined to drive a majority of the FAA R&D programs. In addition, as the JPDO is focused on longer term transformational concepts, there is a tension between those needs and the R&D required to address nearer term issues and to manage the system.

What are the major challenges facing the FAA's R&D program over the next five years?

Building and maintaining the intellectual capability in the FAA as well as supporting R&D organizations, balancing both near term and long term (NextGen) issues, and finding the resources to excel will be challenges.

However, I believe that the major challenge for the FAA R&D program and the agency as a whole will be to find ways to efficiently and quickly implement the technologies, and new operational concepts into the NAS while maintaining or increasing level of safety and minimizing environmental impact. This will be necessary to support both near term and NextGen system transitions. It is unclear if we have the strategic core competency to

effectively implement the new concepts in the NAS and we must develop approaches to enable effective transition.

Figure 5 depicts a simple model of change and system transition in the NAS (developed by one of my students Aleksandra Mozdzanowska) which illustrates this point. Change can be motivated by safety, capacity, efficiency, environmental or other concerns and we often focus R&D on the technology or operational concept aspects indicated on the right side of the figure. However, success will be determined by how well we can implement and develop system capability as indicated on the left side of Figure 5. The time constant for implementation can be very long and most major system changes have historically taken decades.

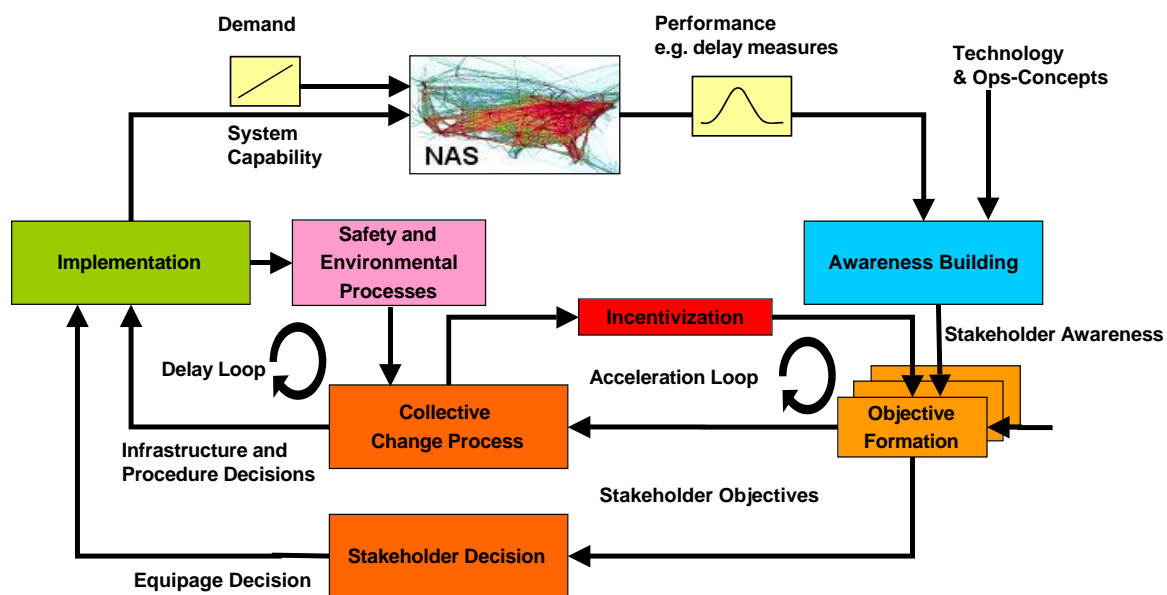


Figure 5. Simple Model of NAS System Transition.

As our expectations for safety and environmental impact have increased, the safety and environmental standards have risen and these can be significant barriers to implementation. Many of the standards post date the basic technical and operational structure of the NAS which has been fairly stable for the past 30 to 50 years. As a consequence there is very little experience in making the type of major system changes envisioned in the NexGen operational concepts, procedures, and capabilities, particularly those which simultaneously require air and ground system changes.

Given the number and complexity of expected operational capabilities envisioned over the next 5 to 10 years the FAA will need to develop new approaches to program management, safety and environmental analysis, as well as efficient processes for operational approval which ensure that safety, environmental, schedule, and cost goals are met.